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## BILHARZIOSIS IN SOUTH AFRICA.

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A FEW years ago it was believed that there was only one form of trematode responsible for the pathological conditions included in the term Bilharziosis, namely a worm, known as *Schistosoma haematobium*, which has had numerous other synonyms, but as I am dealing with the subject purely from a South African point of view, I need merely mention that given it by Dr John Harley, namely *Distoma capense*.

It is now recognised that there are several varieties of Bilharzial parasites.

In South Africa, I have only found evidences of *Schistosomum haematobium* in both its vesical and intestinal manifestations. *Schistosomum japonicum* has not come under my notice.

In this country the disease caused by these parasites is an important one, especially among the native races; far more important than I think is generally believed. So many medical men, born in this country, have in their youth passed blood-stained urine, or have been accustomed to hear of friends doing so, without suffering apparent serious consequences, that they are liable to look upon it as an affection of the bladder only, and to attach little importance to it, forgetting possibly that it may attack other organs, frequently with serious consequences.

In many parts of the Cape Colony and the Transvaal, a large number of the European youths contract the disease. School boys in these parts have competitions as to who can pass a urine of the deepest colour, and the boy most seriously infected is considered more fortunate than his fellows.

Doubtless most of the European boys in Cape Colony, Natal and the Transvaal get rid of all symptoms at about 20 years of age, the disease dying out, possibly because the patient is removed to some

place where re-infection cannot occur. But among the natives living in the tropical or semi-tropical parts, the complaint does not take such a favourable course.

There is probably no disease which causes the native inhabitants of the Province of Mozambique so much worry and anxiety as Bilharziosis. They attribute every evil under the sun to it: impotency of men and sterility in women, are often considered the result of infection. I must admit there seems some justification for the belief. There cannot be any doubt that the disease in any case has a debilitating effect on the native's constitution, probably rendering him more subject to tuberculosis and other diseases when he leaves his kraal to seek work in a colder climate. When the parasite attacks the intestine the result is often fatal.

#### *Geographical Distribution in South Africa.*

In 1851, Bilharz and Griesinger discovered that the haematuria in Egypt was due to the presence of a trematode worm and its ova in various parts of the body. In 1864, Dr John Harley announced the discovery of the parasite in Port Elizabeth and Uitenhage (Cape Colony) and renamed the parasite *Distoma capense*. In 1888, Dr Chute, of Kingwilliamstown, wrote an important article on the subject, connecting it with the Buffalo River. Dr Darley Hartley, when practising in Kingwilliamstown and Cathcart, also had many cases of the disease, traced to bathing in this same river. It is well known that it occurs in many other places in the Colony. Dr Saunders, of Grahams-town, mentions Keiskama, Alice, Konap, Fort Beaufort, as being villages from which he has received patients who were suffering from the complaint. Several natives suffering from the parasite told me they lived near and bathed in the St John's River in Pondoland. In Pietermaritzburg (Natal), European youths have been known to be extensively infected for many years. Dr Brock (1893, *Journ. Pathol. and Bacteriol.* vol. II. p. 52) has demonstrated the prevalence of the disease in the Rustenberg district (Transvaal), especially along the slopes of the Magaliesberg and Pilansberg mountains, and in the valley of the Eland, Hex, Magalies, and Crocodile Rivers. More recently, Dr Stock, Asst. M.O.H., Johannesburg, reported on an outbreak occurring among freshly imported English troops who had bathed in the Aapias river at Pretoria. The same author states that cases have been traced from the Orange River, Vaal River, Mnkanda (Newcastle, Natal), Mooi

River, Klip River, Umzindusi (Maritzburg), and streams in Middelburg (Cape Colony and Transvaal). In 1907, Capt. Gatt, R.A.M.C., contributed an article on the occurrence of the disease among European troops infected in Middelburg (Transvaal), and since then, Dr Arnold has reported that numbers of the civil inhabitants of Middelburg, who have bathed in either the Groot or Klein Oliphants River, have contracted the complaint. It is said that in the Klein Oliphants River there is one particular pool in which it is considered to be especially dangerous to bathe.

A statement has been made that people do not contract Bilharziosis in those rivers running west. This statement is borne out to some extent by references to Table I, which gives the result of microscopical examinations of samples of urines taken from natives of various tribes. It may be noticed that in no case were any Damaras or British Basutos found to harbour the parasites. Further, an educated British Basuto, employed in the hospital, tells me that he has never heard of people in his country passing blood with their urine.

The foregoing information collected from various sources should, with Table I, which gives results of urine examinations, and Table II, giving the number of times the parasites were found in livers at autopsies, make the geographical distribution fairly clear. These tables should also assist one in forming an estimate of the percentage of natives infected in each tribe, but a more accurate idea on this point can be obtained by referring to Table III, under the heading of Parasites.

Besides these:—

<i>Triodontophorus deminutus</i>	was found on	1	occasion,
<i>Physaloptera mordens</i>	„ „	2	occasions
<i>Trichocephalus trichiurus</i>	„ „	2	„

We see therefore that about 33·5% of natives have the *Bilharzia* parasite in the liver. The finding of the parasite in that position is often a matter of difficulty, consequently it must be admitted that any conclusions drawn from these figures will err on the small side.

The figures showing the numbers of other parasites found demonstrate the extent to which the South African native is infected. We may therefore consider the disease to be spread over the following areas. Commencing at the north, Nyassa, Mozambique and Quilimane natives are largely infected, that is to say, the people inhabiting the East Coast country between the southern border of German East Africa and

the Zambesi. South of the Zambesi, we find that natives recruited near Beira, on the banks of the Pungwe river, carry the parasite. In the area inland to this strip of coast country, we see in the Table II that a certain percentage of the British Central African natives, those from the eastern border of Lake Nyassa, the Angonis from the banks of the Zambesi, the Makalanga from Matabeleland, have the disease. On the coast line, south of latitude 22° S. are the Myambaams, Mtyopis, Shangaans and Lourenco-Marques boys; each of these tribes has a certain number of their people infected. That is to say, those people living between the Big Sabi river and Lourenco Marques. Inland of these coast countries, we have Swaziland and the Transvaal. Table I shows that some of the Swazis have the disease, and we know from reports concerning the European population that many parts of the Transvaal are grossly contaminated. The number of sick natives

TABLE I.

*Showing the results of microscopical examination for Bilharzia ova of a number of urines collected from various tribes of natives.*

Tribe	Number examined	Positive results	Percentage
Mozambique ... ..	190	48	25·8
Quilimane * ... ..	60	3	5
Lake Nyassa ... ..	22	8	36·3
British Central African ... ..	80	7	8·7
Shangaan ... ..	32	6	18·7
Mixed East Coast gang of Shangaan, Mtyopi, Myambaam, and Lourenco-Marques boys ...	225	26	11·5
Zulu ... ..	34	8	23·5
Pondo ... ..	10	2	20
Swazi ... ..	44	8	18·1
Mxosa ... ..	39	2	5·1
Transvaal Basuto † ... ..	59	1	1·6
British Basuto ... ..	68	—	0·0
Makalanga ... ..	45	10	22·2
Damara ... ..	50	—	0·0
Bechuana ... ..	12	2	16·6
Total	970	131	14·0

\* The results obtained from the examination of urines taken from these natives are interesting. The boys were not fresh recruits; they had all been working on the mines for 12 months. The ova in those urines giving positive results were few and far between. Post-mortem examination of fresh recruits show a very much higher per cent. infected. See Table III. This seems to suggest the advantage of removing patients from an infected area.

† The positive result obtained among the Transvaal Basuto was in urine from a boy who had been living in the Rustenburg district for some time.

TABLE II.

*Showing the number of times the Bilharzia worms were found at autopsies held on natives of various tribes. Also the number of times with which intestinal parasites were present.*

Tribe	No. examined	Bilharzia worms in liver	Ankylostomes	Round worms	Tape worms
Mozambique	215	102	139	17	1
Quilimane	129	60	81	32	1
Nyassa	52	16	27	10	2
British Central African	10	4	2	1	1
Beira	3	1	2	0	0
Angoni	14	2	3	1	0
Shangaan	65	23	32	27	2
Tonga	6	0	1	1	2
Myambaam	106	28	30	36	7
Mtyopi	40	9	15	8	8
Transvaal Basuto	12	1	1	0	1
Damara	19	0	2	1	0
Swazi	1	0	0	0	1
Pondo	6	0	0	1	3
Mxosa	5	0	0	2	1
Mixed Races	9	0	0	0	0
Total	692	246	335	137	30

from the Transvaal coming under my care is not so large as from other parts of South Africa. I have not therefore personally much evidence on the subject, but a medical missionary, Dr Liegme, in a paper he read before the Society for Advancement of Science in South Africa, states that haematuria is frequent in the Spelonken. Table I demonstrates the Zulu to be infected, and we know that the European population in parts of Natal likewise have the disease. I have had several cases among Amapondo and Amaxosa natives of Cape Colony, and as I have already stated the disease is prevalent in many places in the Eastern Province. Of the Western Province, I cannot speak definitely. British Basutoland has, so far, produced no patients for me. Damaraland is also free as far as I can judge by examining recruits from that country. Of the Orange River Colony, I am not in a position to speak decidedly, but I think one may anticipate that a certain percentage of the population on the north-eastern border will be infected.

*Source of Infection.*

That the disease is conveyed by some means from infected water there is no doubt, but except that the miracidium is killed by minute traces of hydrochloric acid not a single experimental fact has yet been brought to light indicating the actual source and mode of infection. The old idea in Cape Colony, still adhered to curiously by some, was that the organism in some form crept up the urethra while the persons were bathing. For this reason some of the inhabitants of Cape Colony used to tie their genital organs up in a handkerchief before going into a river to bathe. This custom may have induced some writers erroneously to try and prove that the prepuce cover worn by certain South African tribes was originally adopted as a protection against the parasite.

That infection occurs in some manner while bathing I think there can be little doubt. Dr Darley Hartley, when practising in East London and Cathcart, saw many cases of Bilharziosis. They always occurred in boys or young adults, and he tells me that in almost every case he obtained a history of them having bathed in the Buffalo River.

Dr Brock (1893, *Journ. Pathol. and Bacteriol.* vol. II. p. 52), relates an exactly similar experience when he lived in the Rustenburg district (Transvaal). Dr J. Allen (1888, *Practitioner*, vol. XI. p. 310) at one time Medical Officer for the Corporation of Maritzburg (Natal), writes as follows: "Nearly all the youths bathing in the Umzimdusi and Dorp Spruit are infected, while the girls, who do not bathe, remain free of the disease." In the two outbreaks among English troops in the Transvaal, the men infected had been bathing in spruits or rivers. The only case of a European girl becoming infected, that I can find notes of, is one reported by Dr C. P. Childe (III. 1899, *Brit. Med. Journ.* p. 644), and this girl, it was found on enquiry, had been in the habit of bathing in a freshwater pool on a farm in Natal. The facts seem to support the theory that infection occurs through the skin, for if the disease is contracted through drinking water, the girls would be infected as well as the boys, as, though the girls rarely bathe, they, in most cases drink the same water.

Moreover, when travelling among the natives on the East Coast, where both sexes drink the same water, and both bathe to about the same extent, I noticed that the women seemed, if anything, more commonly infected than the men; certainly the most severe types of the disease occurred among females. I was constantly requested to give medicines for women who were passing blood in their urine.

Dr Brock says that persons bathing in the streams skirting Rustenburg complain of severe itching when emerging from the water. Dr John Harley noticed that people in Cape Colony often suffered from nodular excrescences of the skin, which later became transformed into indolent ulcers. He considered these consequent upon the invasion of the parasites into the skin when bathing. Personally I have not come across any skin eruptions which in any way suggest the entrance of any kind of embryos or larvae, unless perhaps a native skin disease known as Dwappo.

I think the preceding statements make it far more probable that infection does not occur by the drinking water, but rather through the skin while a person is wading or washing in infected rivers or pools, the worm entering in the same manner as the larvae of the *Ankylostoma duodenale*.

It has been urged against the probability of infection occurring through the skin while bathing, that monkeys contract the disease, and these animals certainly do not bathe, while they constantly drink water from streams or pools when they cannot get dew, and in doing so, probably immerse their feet at the edge of the water. It seems to me most probable that the disease is contracted either by bathing or wading in infected water or mud.

I may add here that Europeans have noted that certain pools in the rivers are more fruitful in producing cases of the disease than others. The natives on the East Coast state that some cases are produced by bathing in certain pools, but they also state that it is caused by drinking M'Jumbula spirit (a filthy spirit made by the distillation of a preparation of manioc root)!

Cobbold originally suggested that there must be an intermediate host in the life history of the parasite, but to the discussion of this subject I am not in a position to add any fresh information.

#### *Incubation Period.*

Dr Stock in his article on *Bilharzia*, published in the *Lancet* of September 29th, 1906, quotes the cases under Dr Abercrombie's charge which occurred among newly arrived drafts of young soldiers who bathed in supposedly infected pool near Pretoria. Of these, the shortest time in which symptoms developed after bathing was one month, the longest two months. He accordingly concluded that the incubation period lasted about six weeks.

In connection with this it must be remembered that people can probably carry the parasites for some considerable time without any signs of the disease being apparent, provided they lead a quiet life, but the symptoms may at any time appear suddenly in consequence of some severe exertion. That the period of incubation according to Stock is shorter than that observed by others may be due to the fact that the troops in question were cavalry, subject to rough riding; a form of exercise most likely to bring on the symptoms at an early date.

### *Symptoms.*

Before discussing this portion of the subject, I must state that a number of my patients spoke a language understood by no Europeans that I know, and by very few natives. Consequently, to obtain any account as to how the patient really felt was difficult and to obtain anything approaching an accurate history of the cases was impossible. But the symptoms I noted do not appear to vary much from those reported, as occurring among the inhabitants of other countries. It is therefore only necessary to discuss them briefly.

They appear to vary in severity in different localities. Consider for example the case of European and native youths in parts of the Transvaal, Natal and Cape Colony, where, though numbers are infected, the majority only have a certain amount of haematuria; they may at times show evidences of debility, but they are not often really seriously incapacitated. On the other hand, among the natives on the East Coast and more tropical parts, there is, as stated before, probably no disease which causes the inhabitants so much worry as Bilharziosis.

This may probably be due to there being more than one species of parasite; the population of the southern parts are only infected with the variety of disease which attacks the urinary system; that of northern and tropical parts harbouring both kinds. At the same time, it is also possible that the infection in the northern districts may be more extensive than in the southern.

The individual symptoms may be divided into those affecting (1) the urinary system; (2) the intestines.

### *Urinary System.*

Haematuria is the most prominent and important symptom of them all.

It occasionally appears suddenly; the result of an accident. I had



a patient, a young Pondo, who told me he first noticed that he was passing blood in his urine after a fall from a horse.

In some cases, though the urine appears quite clear, if it is treated in a centrifuge, and then examined under a microscope, red blood corpuscles and a few ova will be found. At other times, the whole urine passed is faintly blood-stained, or the first water evacuated may be quite clear, a few drops of pure blood only appearing at the end of micturition. With some cases, small tube-shaped blood clots are passed in the urine stream. In the most severe cases, almost pure blood is emitted and occasionally this may coagulate in the bladder so firmly as to cause complete suppression of urine. I have only seen the last condition once; it was a case of a European who came from the Rustenburg district.

With severe haematuria cystitis often develops, thus necessitating frequent micturition, which, with the anaemia and the mental worry, has a very debilitating effect on the system. I must, however, admit that I have never had a native or European die of uncomplicated *Bilharzia* disease of the bladder, though I have seen some excessively severe haemorrhages as a result of it.

The haematuria is frequently brought on by violent exertion, especially riding.

On several occasions, I have had patients admitted to hospital who rolled on the floor in intense pain, which they referred to the pubic region; they had apparently no other symptom, though one native had incontinence of urine. With a catheter a small amount of purulent urine, containing *Bilharzia* ova, was drawn off. When I first saw these patients I thought they had received an irritating poison, and that possibly some native doctor had been administering a mixture somewhat more searching in its effects even than those they usually employ. However, hot fomentations, hypodermic injections of morphia and urotropine administered by the mouth, relieved the symptoms, and after a few days the patients recovered sufficiently to be transferred to the convalescent room. They remained fairly well there for a week or two. After this time, they were readmitted to hospital with indefinite symptoms and often died suddenly within a few days. At other times, these patients lay wrapped in their blankets in a drowsy condition for days and weeks. Beyond the fact that their urine contained albumen, which is so common an occurrence among native patients, that one has to disregard its presence, there were no symptoms indicating the cause of the condition. The temperature on admission usually being above

normal, but within a few hours falling to subnormal and remaining so until death.

A post-mortem examination usually showed that all the organs except those of the urinary system were healthy. But the kidneys were in a state of profound hydronephrosis, the organs being mere shells.

#### *Urinary Fistula.*

In accounts of the disease by Egyptian observers fistula is noted as a common complication.

The number of natives I see suffering with fistula is small. I have never seen one which I suspected was due to Bilharziosis. But most of my patients are adult males in the prime of life; the condition may be more frequent among the old men, unfit and unlikely to seek for work away from their own country, though when I have been in the kraals I have not noticed an abnormal number of perineal complaints.

Of the many complications which must occur when the parasites attack the genito-urinary organs of the female I have had no experience.

#### *Intestinal Bilharziosis.*

The symptoms of this condition in my experience are exceedingly indefinite; they are most liable to be mistaken for those of chronic diarrhoea or dysentery.

Those cases I have diagnosed during life have been identified more by the exclusion of other diseases than anything else. Because though I make microscopical examinations of the faeces, the number of ova found in the specimens often did not convey any correct impression as to the extent of the disease. It seems that the ova really causing the mischief are those working in the tissues. One may even, in severe cases of Bilharzial infection of the intestine, experience a little difficulty during life in demonstrating the ova, though after death a scraping from the mucous membrane of the rectum shows the tissues to be infiltrated with them.

This peculiarity of the disease accounts for it not being more often recognised when examinations of faeces are made say for the ova of *Ankylostomum duodenale*. When I see a patient suffering from chronic diarrhoea passing five to six motions daily without much slime or blood, and not responding to ordinary treatment, but wasting and becoming anaemic to a degree quite out of proportion to the extent of

the diarrhoea, I suspect Bilharziosis. I do not wish to infer that my patients never pass blood or slime in their motions but, as a general rule, they have not done so; their motions recall those of a patient with acute tuberculosis, complicated with diarrhoea.

Straining and tenesmus have not been marked features of the disease, though one patient was in agony for several days before death unless under the influence of morphia. I particularly lay stress on the absence of these symptoms, because I note in other countries they are reported as being marked features of the disease. It may be interesting to note here that, though I have experienced some most virulent epidemics of dysentery among natives, attended by a very heavy mortality, tenesmus, which is most frequently a very trying feature of the disease when Europeans are attacked, was comparatively uncommon among my coloured patients.

#### *Temperature.*

The temperature in intestinal Bilharziosis cases under my notice has been, as a rule, normal or subnormal, varied at intervals of seven or eight days by a two or three days irregularity. This disturbance may have been of malarial origin; at the same time I suggest it may have been due to a crop of embryos or miracidia having burst from the ova into the tissues.

#### *Duration of the Disease.*

In Cape Colony and more southern parts of South Africa one generally expects the symptoms to abate and finally disappear when the patient reaches to about twenty years of age. But that the disease may persist for a long time without any re-infection occurring is proved by Maj. Freeman (III. 1907, *Journ. Roy. Army Corps*, vol. VIII. p. 278) who quotes the case of a soldier who was infected in Pretoria and afterwards returned to England. Three years after his return, living ova could still be found in his urine. I am inclined to think it doubtful whether a person, once he has contracted the disease, and the walls of his bladder and the surrounding tissues have become impregnated thoroughly with calcified ova, will ever be completely free of all evidences of the complaint. I think that years after all active mischief has ceased, scraping of the bladder tissue would still show calcified ova, or their débris. That is to say, the ova can be demonstrated long after the actual trematode producing them has been destroyed and absorbed.

*The Parasites.*

I do not intend to enter into the anatomical description of the actual parasites or to give an account of the dimensions or other minute details of their ova. That is a matter to my mind requiring the knowledge of an expert helminthologist.

The natives of South Africa are infected then with the two forms of the disease, viz. the classic form and Manson's Bilharziosis.

I have found both terminal and lateral spined ova at autopsies and when examining the excreta from patients in hospital, and I believe the parasites which deposit these two distinct forms of ova normally infest different organs, though the terminal spined ova occasionally trespass on the preserves of the lateral spined one.

I have been able to find the worms most readily in the portal veins of the liver (see Table II), but the parasites in that situation are, I understand from Dr Leiper (London School of Tropical Medicine), to whom specimens were submitted, of the male sex and immature. To find the mature worms it is necessary to examine the ramifications of the venous system of the bladder and rectum. I have never found worms or ova in the arterial system.

Some of the ova probably remain in a calcified state long after the worms have disappeared from the system. That there may be two separate trematodes is, I think, supported by the fact that the terminal spined ova is the only variety ever found by me in the urine or mucous membrane of the bladder and ureters<sup>1</sup>.

In the faeces and mucous membrane of the large intestine lateral spined ova are generally found, with sometimes, however, a few terminal spined ones amongst them, and these latter are frequently in a calcified state, suggesting that they have worked their way from the bladder tissues rather than that they have been deposited by the blood stream. On four occasions at autopsy (examinations on two Angonis, one Shangaan, and one Quilimane native) I found lateral spined ova in the mucous membrane of the large intestine, but although I carefully scraped and examined every portion of the mucous membrane of the bladders, no ova of any kind could be found in these organs.

My observations of the occurrence of the lateral spined ova are

<sup>1</sup> In a discussion reported in the *Lancet* of April 20th, 1889, Dr Moon stated that "he had found both terminal and lateral spined ova in both bladder and rectum." This statement does not hold good in South Africa.

confined to what is known as the low veldt in South Africa. I have not found lateral spined ova in natives coming from other than tropical or semi-tropical parts. There is too the marked difference in the severity of the general symptoms of the disease in the two localities.

To demonstrate approximately the number of times the terminal spined ova were produced as compared with the lateral spined ones, and also to ascertain in what proportion of cases both kinds of ova could be found in the same person, I made a careful microscopical examination of scrapings taken from the mucous membrane of the bladders and large intestines obtained at 90 consecutive autopsies. These examinations were conducted with special care, and I think the results given in the following Table III may be relied on absolutely.

TABLE III.

*Showing results of microscopical examination of scrapings taken from the mucous membrane of bladders and large intestines at 90 consecutive autopsies; also showing the number of times the Bilharzia worm was found in the vessels of the liver.*

Tribe	Total no. of examinations	Bladder			Large intestine				Liver	
		Terminal spined ova	Lateral spined ova	Not microscopically examined*	Lateral spined only	Terminal spined only	Mixed lateral and terminal spined ova	Not microscopically examined	Worms present	Not found
Myambaam	11	10	0	0	2	1	2	0	3	8
Mtyopi	5	5	0	0	3	0	0	0	1	4
Shangaan	8	7	0	0	2	1	0	1	2	6
Nyassa	3	3	0	0	0	0	0	0	1	2
Mozambique	30	24	0	2	3	5	3	4	10	20
Quilimane	15	12	0	0	4	0	2	2	4	11
Angoni	15	11	0	2	4	1	2	3	3	12
Transvaal Basuto	3	2	0	0	0	0	0	0	0	3
Total	90	74	0	4	18	8	9	10	24	66

\* A few separate organs escaped microscopical examination for unavoidable reasons; the numbers so escaping have been noted in a special column.

In four of the above cases, namely, two Angonis, one Shangaan, and one Quilimane native, lateral spined ova were found in the mucous membrane of intestine but no ova could be found in the bladder. In only nine cases was the *Bilharzia ovum* absent in all organs. One Mozambique native gave negative results in the bladder and intestine but a single *Bilharzia* worm was found in the liver. The numbers of terminal spined ova found in mucous membrane of the large intestine were usually very few.

To Table III, I may add that I found the terminal spined ova in the following organs :

- |              |                                |
|--------------|--------------------------------|
| (1) Bladder. | (5) Veins of foregoing Organs. |
| (2) Ureters. | (6) Prostate Gland.            |
| (3) Kidneys. | (7) Mesenteric Gland.          |
| (4) Rectum.  | (8) Lungs.                     |

I have not examined the heart or pancreas for ova, and on only two or three occasions, the spleen substance. I examined the urethra on several occasions, always with negative results.

The lateral spined ova I found principally in the rectum and occasionally a few in the liver. It is interesting to note that I have not found the terminal spined ova in this last organ, though I expected to do so.

The above facts seem to point to a wide area of location of the terminal spined ovum, but a much more restricted field for lateral spined ova.

#### *The Ova.*

The following is a rough description of the two forms of ova, as I have seen them, which may be of interest, though it does not enter into minute details.

#### *Terminal Spined Ova.*

These may be observed in three forms:—

(a) The light coloured animated ovum with the clear well marked contents.

(b) The ovum with homogeneous black contents, which are apparently calcified, evidently dead and incapable of doing any more damage to the tissues than coarse pigment granules would do.

(c) Shells of ova from which the miracidia or embryos have escaped.

Those ova found outside the urinary system or intestines were, to the best of my recollection, all of them in the calcified condition described under heading (b).

#### *Lateral Spined Ova.*

These may also be seen in several forms:—

(a) The light coloured animated ovum with the prominent lateral spine.

(b) The light coloured animated ovum, with a spine looking like a thin thorn projecting from the surface.

(c) The ovum with a very thick spine, producing the appearance almost of a division of the lower end of the egg. This represents, I believe, the calcified state in the terminal spined ovum.

(d) Shells of the lateral spined ova from which the embryos have escaped.

As regards the first two forms of the lateral spined form, it must be noted that at times, on first looking at them, it appeared as though they had no spines at all. But immediately on pressure being brought to bear on them through the cover-slip, a spine shoots out. I think this is in most cases an optical delusion, and that what really happens is that the ova were lying with the spines on their inferior surface, and that pressure on the cover-slip causes the eggs to turn over, so bringing the spine suddenly into view.

I may mention that I frequently, when examining scrapings from the mucous membrane of the bladders and intestines, found empty ova shells, from which the miracidia or embryos had escaped. In Cobbold's *Entozoa*, it stated that Griesinger found a number of empty eggs in the left ventricle of the heart. Other authorities have doubtless observed the same fact. I have also, when examining perfectly fresh specimens, especially those taken from the mucous membrane of the rectum, observed that the slightest pressure has caused the ova to burst and the field of the microscope has been suddenly populated by numbers of rapidly moving miracidia. These statements suggest to my mind that the ova do occasionally dehisce while still within the human system, and explain occasional evidences of recrudescence of the disease.

### *Pathological Anatomy.*

The changes caused by this parasite are principally to be seen in the urinary and alimentary systems.

#### (1) *Urinary System.*

*Calculus.* I am dealing with this subject separately, as I consider my observations are of especial interest. I notice that in Egypt the frequency with which natives suffer from stone in the bladder is ascribed to Bilharziosis. In South Africa, of the 66 autopsies I have made on natives infected with the disease, in which the bladder has been particularly examined, I have not once found a stone. Further, I

have never had a patient presenting the clinical symptoms of calculus of the bladder. In view of Egyptian records this experience appears extraordinary.

*Bladder.* This organ is the one most commonly affected. As stated before, I have only made four autopsies on natives found to harbour the parasite, in which the bladder escaped infection. The effect of the ova on the coats of the organ varies greatly, according to the numbers present, and to the length of time they have had to produce the changes.

In some the only feature noticeable on first opening the bladder is a small slightly inflamed spot on its mucous membrane; in others, one is at once struck by the presence of several acutely congested papilliform bodies projecting into its interior, which would undoubtedly bleed when squeezed by the contraction of the bladder at the end of micturition. In more advanced cases still, the area of acute congestion is extensive, affecting nearly the whole of the internal surface, in the centre of which there may be a patch of black gangrenous mucous membrane, easily detachable. Such a condition might result in a very large haemorrhage. It would appear that the varying degrees of inflammation described above represent the sub-acute and acute stage of the disease, and that at a later date, when the parasite dies out, or the ova for some reason lose their activity, other changes occur, which can be looked upon as representing a more or less chronic condition.

I make this statement, because, in other bladders I have found on careful examination faintly coloured brownish spots on the mucous membrane, not gritty to the touch, or raised above the surface, in which a few terminal spined calcified ova can be found on microscopical examination. This condition is, I believe, the chronic stage of the sub-acute condition described first, in which there was only very slight congestion.

Following this stage a little further, one finds bladders in which there are four to five greyish-brown patches, of about 15 mm. in diameter, slightly raised above the surface of the mucous membrane; these when scraped with a scalpel can be heard and be felt to be gritty. Later still the spots are much more elevated, and have blackened tops, which project into the bladder, and resemble warts which have been burned with caustic. In other bladders, nearly the whole extent of the internal surface is affected. Such bladders when opened and spread out, resemble a sheet of very fine sandpaper, and on the surface of some of them I have seen small pin-head vesicles, which are hard, feeling like



small nodules of cartilage. They have an opalescent appearance, glistening in bright sunlight. If one of these vesicles be removed and placed under a cover-slip it takes a certain amount of pressure to burst it. Microscopically, it consists of a capsule containing a little clear or cloudy fluid, in which is suspended a nest of black terminal spined ova, or the débris of ova. I think it may be stated that the various coats of the bladder become thickened to a greater or less degree in every case of the disease (due to the interstitial growth of fibrous tissue. See Bowley, *Lancet*, April, 1889). In some, the thickening is very slightly marked, but in others they may be half an inch thick, like the walls of a uterus. Such a condition greatly reduces the capacity of the organ, and at the same time diminishes its power of expansion.

*Ureters.* These are the organs which, next to the bladder, are most commonly affected. The portions of the ureters which pass through the bladder wall, and the first two inches of their lower ends, are the parts usually implicated. Occasionally patches of infection of about an inch in extent, may be found midway between the bladder and the kidneys, sometimes even nearer than this to the latter organs. The conditions of the mucous membrane of these tubes vary markedly. In some the affected parts have a soft pale cream-coloured velvety appearance. In others there are dark brown gritty patches. When such occur near the bladder, the lumen of the tube is frequently distended, and almost blocked with masses of brown sandy material looking somewhat like coffee grounds. On one occasion I removed about half a tea-spoonful of this substance from each ureter, which microscopically I found to consist of black terminal spined ova and their débris.

Once I found the mucous membrane sprinkled with dark specks like black powder grains. These were exceedingly hard. I broke a cover-slip in crushing one of them. I believe they consisted of calcified débris of ova, and that they are a secondary condition to the little vesicles already described as appearing in the bladder, as I found similar vesicles in the ureters in close proximity to the black specks. On one occasion the lumen of the left ureter was completely obliterated in four places, and the kidney on the corresponding side was cystic and atrophied. With adherent tissues it only weighed 37 grammes.

The walls of the ureters become hypertrophied in the same manner as do those of the kidneys.

*Kidneys.* Calculus. On only one occasion have I found a stone in the kidney. It was about the size of a millet seed and lay in the calyx of the left organ.

Though I have constantly traced the *Bilharzia* ova from the bladder up the ureters to hilum of the kidney, it would seem that it is comparatively rare for the kidneys themselves to be affected by the disease in its acute stage, the ova not being found in the substance of these organs in large numbers. But the kidney is sometimes markedly affected secondarily to the pathological changes in the bladder and ureters. There are three main causes inducing kidney changes: (1) as the coats of the bladder become thickened they tend to cause a partial occlusion of the lumen of the ureters passing between them; (2) the deposit of coffee-ground material already described, at the lower end of the ureters, reduces their lumen; (3) the thickening of the coats of the ureters has the same effect.

These three conditions retard the urine from entering the bladder, and set up a back pressure, which eventually causes hydronephrosis and later pyonephrosis, in some cases to such a degree that after death the kidneys are found to be mere shells. The following table shows the number of times, in 420 autopsies, in which there were cysts in the kidneys or the calices were dilated.

TABLE IV.

Tribe	Number examined	Cystic kidney	Per cent.
Nyassa	36	0	0·0
Mozambique	160	15	9·4
Quilimane	56	6	10·7
Beira	2	0	0·0
Myambaam	64	7	10·9
Mtyopi	24	0	0·0
Shangaan	38	1	2·6
Tonga	2	0	0·0
Angoni	15	1	6·7
Mashona	1	0	0·0
Basuto	7	1	14·2
Mxosa and Pondo	5	0	0·0
Damara	10	1	10·0
Total	420	32	or 7·6

I have seen it stated that the kidneys of persons affected with *Bilharziosis* weigh more than the normal. This, one would naturally expect to be the case, but my limited figures do not bear the statement out, as, out of five cases which I proved microscopically did not contain the ova in the bladder, the average weight of the two kidneys was 28·4 grammes, whereas the average weight per pair of fifty pairs of kidneys

taken from bodies proved microscopically to have the ova in the bladder was only 270·75 grammes. The figures are too few to place much reliance on them, but they strike one as peculiar. Of the other parts connected with the genito-urinary system, I shall refer to :

*Prostate gland.* I have frequently found a few nests of terminal spined ova in this gland. I have not seen any marked naked-eye lesion in it, and my attention has not been called to it clinically in any way.

*Urethra.* Though I have examined the lining membrane of this tube microscopically on several occasions, I have never found it to be affected. But I note that in other countries the urethra is sometimes attacked.

*Foreskin.* On several occasions I noticed a hypertrophied condition of the foreskin, which I suspected to be caused by Bilharzial infection but I have never confirmed the diagnosis.

*Alimentary canal.* The large intestine is the portion of the alimentary canal most frequently affected. In some cases the mucous membrane of the lower bowel is acutely congested, without any evidence of ulceration. At other times the whole surface seems honey-combed with clear punched-out ulcers of about the size of a split pea. In others again, there is a granulating condition, reminding one of the surface of the skin following a burn, in that state which, as a student, I was taught should be rubbed with bluestone before any attempt should be made to skin graft. At a later stage to this a papillomatous condition is found, reminding one of haemorrhoids.

Besides these acute conditions a stage is often found, which I believe corresponds to the chronic sandy stage in the urinary system—black leaden-coloured patches of mucous membrane without ulceration, a deep scraping from which shows black lateral spined ova. In some, this pigmented state may be so marked that the whole surface of the mucous membrane looks like a strip of black velvet. This peculiar colouration has always been associated with lateral spined ova. As in the bladder, so in the intestines the various coats are greatly hypertrophied.

I have not looked for the disease in other parts of the alimentary tract, but Dr May, the Government Bacteriologist, examined a cyst from the stomach of an imported Chinaman, which contained terminal spined ova.

*Liver.*

The numbers of South African natives who contract a cirrhotic condition of the liver is, I think, large. In the following table, No. V, we see that out of 739 post-mortems, the liver was found to be cirrhotic on 106 occasions, or 14·3%.

TABLE V.

*Table showing the number of times in which at 739 autopsies the liver was found to be cirrhotic.*

Tribe	No. of examinations	Cirrhotic liver	Percentage
Nyassa	53	5	9·4
Mozambique	221	27	12·2
Quillimane	132	29	21·9
Myambaam	114	21	18·4
Mtyopi	44	7	15·9
Shangaan	74	10	13·5
Tonga	6	1	16·6
British Central Africa	15	3	20·0
Matabele	1	0	0·0
Makalanga	4	1	25·0
Transvaal Basuto	11	1	9·1
Zulu	1	0	0·0
Mangwato	2	0	0·0
Rhodesian	2	0	0·0
Beira	2	1	50·0
Angoni	15	0	0·0
Mashona	1	0	0·0
British Basuto	2	0	0·0
Pondo	8	0	0·0
Mxosa	4	0	0·0
Fingo	1	0	0·0
Damara	26	0	0·0
Total	739	106	or 14·3

Whether this cirrhosis is entirely due to *Bilharzia* is, I think, doubtful, as, though when we analyse the Table, we see that the tribes with the highest percentages affected with cirrhotic livers come from those areas where the lateral spined ovum is most prevalent, yet it must not be forgotten that these are also the very districts where malarial fever exists in its worst forms, and where, above all, alcohol is consumed by the natives in enormous quantities. In the Portuguese Territories natives can obtain as much imported spirit as they can pay for. Furthermore, numbers of them are adepts at the distillation of

spirits. Provided with a couple of kaffir pots and an old gun barrel, the native soon starts a very efficient distillery. The country abounds with vegetable products from which he can make spirits, the two commonest of which are, I think, the Cashew apple and the Manioca root. In consequence of the ease with which a native can obtain alcohol, he consumes, as stated, enormous quantities, and I think it may truly be said that, in certain seasons of the year, he is never properly sober.

If we consider the other liver complaints from which the native suffers, viz. waxy disease or fatty degeneration, we find them to be above the normal, as shown in the following Table :

TABLE VI.

*Table showing number of times the liver was found to be either waxy or fatty at 400 autopsies.*

Tribe	Number examined	Waxy	Fatty
Shangaan	38	4	3
Myambaam	64	4	3
Mtyopi	24	3	0
Nyassa	36	1	1
Mozambique	180	2	6
Quilimane	56	1	3
Beira	2	1	0
Total	400	16	16

I do not think that it has been suggested that Bilharziosis is responsible for either of these conditions.

The trematode itself is not found most frequently in the cirrhotic livers, as, out of a hundred consecutive autopsies, fourteen showed a cirrhotic condition of the liver, and in these the worms could only be found twice, whereas they were found twenty-four times in the remaining livers, which were either normal or merely congested. This feature may be due to the fact that the cirrhotic liver has often very little blood in it, consequently it is difficult to express the worms. And it is also possible that the worms only stay in the liver when in an immature state, therefore not laying eggs; that at maturity they seek other spheres, and the eggs then laid are carried back to the liver and set up the cirrhotic condition.

I am not in a position to speak too definitely on this matter, but the number of ova found in the liver tissues does not appear to be sufficient to warrant the conclusion that they are responsible for the cirrhosis.

It is generally accepted that the ova, and not the worms, cause the pathological changes.

#### *Mesenteric Glands.*

These glands in a patient with intestinal Bilharziosis are slightly enlarged: they are of a very dark colour and of hard consistence. I have frequently found terminal spined ova when examining scrapings taken from them.

#### *Lungs.*

Of the few lungs I have examined I have only found the ova on one occasion (terminal spined ova) in a boy who died from acute pulmonary tuberculosis. The tuberculosis was evidently secondary to the Bilharzial infection. It is reasonable to suppose that a Bilharzial infection of the lungs would render the patient more susceptible to infection with *Bacillus tuberculosis*. It is interesting to note that Cobbold suggests the peculiar susceptibility of the South African native to pneumonia may be the result of Bilharzia.

#### *Treatment.*

I have only heard of three native remedies, but doubtless many others exist: (1) A decoction made from the roots of a *Cassia*, growing in Equatorial East Africa, which Dr O'Sullivan Beare obtained from the natives of those parts. This plant has since been named *Cassia beareana*; an extract made from the roots has been used with marked success in the treatment of Blackwater fever (see O'Sullivan, *Lancet* of Feb. 1st, 1902, and Bostock, *Transvaal Med. Journ.* of July, 1907). (2) While among the kraals in the Inhambane District, I was informed by natives that they used a medicine, consisting of a decoction of the leaves of a tree called *Umrangala Umgubo* (spelt phonetically). The use of this plant for bladder troubles would appear very widespread, as a Mozambique boy told me that a decoction of the roots of the same plant was used in his country by persons passing blood in their urine. Among the Mozambiques, he informed me, the plant is known by the name of *Reba Reba*: I regret to say that I have not been able to get this plant identified. (3) A demulcent drink made from the beard of mealie cobs has a great reputation for the treatment of the disease among some natives.

While suffering from an attack of the disease natives in Portuguese Territory abstain from eating Cashew apple (*Anacardium occidentale*) and from drinking wine or spirit manufactured from it. As stated previously, some natives attribute the disease itself to the drinking of manioca spirit.

Kitchenmeister's Manual suggests the use of onions and garlic in the treatment of the disease. Griesinger prescribed a mixture of calomel and turpentine.

Methylene blue has a reputation in some parts. Liquid extract of male-fern in 10 m. doses, twice daily, has its advocates. Santonin, quinine, cubebs, sandalwood oil, benzoic acid, have all been recommended.

Personally I have obtained the best results in the treatment of Bilharziosis affecting the bladder by the use of urotropine, 5 gr. doses night and morning, in half a pint of water, with rest in bed. Should the haemorrhage become severe I use adrenalin. With this treatment I have always been able to quiet the symptoms, but I am inclined to think that I have been singularly fortunate in the class of patient with which I have had to deal.

As regards the treatment of the intestinal disease, I have to admit that I know of no drug which has the slightest influence on it. I have used infusion of monsonia the most frequently, after that magnesium sulphate, opium, astringent remedies and other drugs. I may almost say that I have worked steadily and conscientiously through the British *Pharmacopoeia* without any satisfactory result.

#### *Prognosis.*

This varies according to the system of the body which is infected. If it is purely an uncomplicated case of terminal spined ova affecting the bladder of a male, the consequences are not as a rule very serious in South Africa. If, on the other hand, the disease has obtained a firm hold of the mucous membrane of the large intestine, I consider the prognosis of the case a grave one.